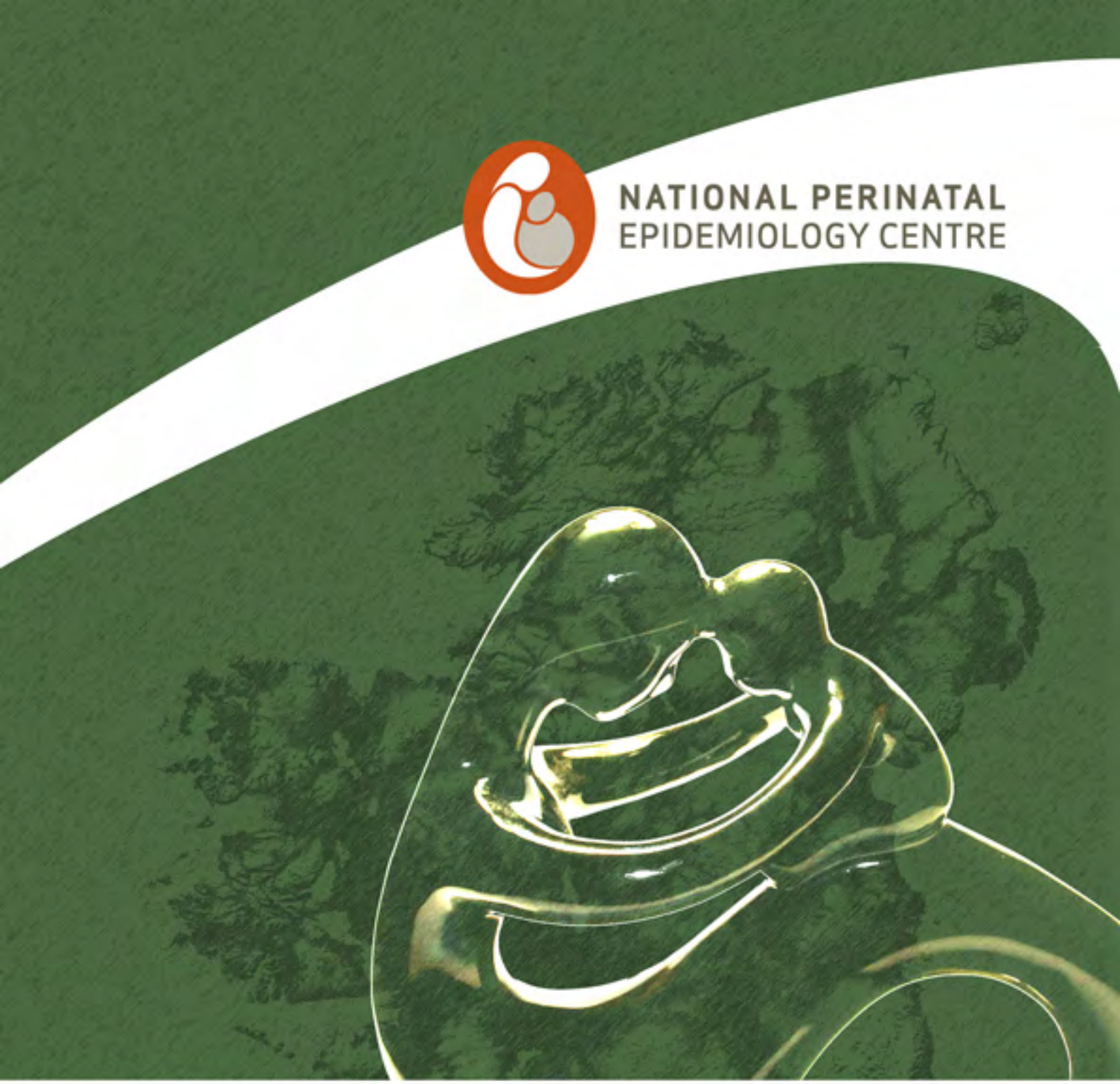
NATIONAL PERINATAL EPIDEMIOLOGY CENTRE



Severe Maternal Morbidity 2011

National Perinatal Epidemiology Centre

Severe Maternal Morbidity Report 2011

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Acknowledgements

I am very pleased to present the first annual Severe Maternal Morbidity Audit report from the National Perinatal Epidemiology Centre (NPEC). Severe maternal morbidity incidence is an important indicator of quality of obstetric care. For this reason, in 2010, the NPEC established a multidisciplinary specialist Maternal Morbidity Group to address the investigation of severe maternal morbidity in Ireland: members of the Group are listed in Appendix A. The Maternal Morbidity Group has since guided the confidential audit of severe maternal morbidity cases reported in Ireland. Furthermore, detailed assessment has been conducted on major obstetric haemorrhage cases. I am happy to announce that this audit has been endorsed by the Clinical Advisory Group at the Institute of Obstetrics and Gynaecology and the Health Service Executive (HSE) National Obstetric Programme Working Group.

To date, we have experienced an overall feeling of goodwill towards the Centre's work and our commitment to improving Ireland's maternity services. Reporting data to the NPEC is not a statutory requirement, but in 2011, 19 maternity units voluntarily provided maternal morbidity data to the Centre, demonstrating the consensus to examine such data on a national level.

Measurement of the outcome of care is central to the development of safe and high quality health care services. Through surveillance of maternal outcomes, we at the NPEC endeavour to provide Irish maternity units with the facility to undertake in-depth reviews of their own service and care.

Whilst all maternity units have become busier in recent years due to the increased birth rate and the recruitment moratorium within the Health Service Executive, it is commendable that personnel continue to supply audit data and review services provided to the mothers and babies at their individual units. On behalf of the NPEC, I extend my sincere thanks and appreciation to the many midwives, administration staff and obstetricians who have supported and contributed data to the NPEC. The audit would not be possible without the dedicated support and co-operation of the unit co-ordinators and their work is gratefully acknowledged.

I would also like to acknowledge the NPEC Advisory Group for their intellectual input as the Centre continues to grow and evolve. Advisory Group members represent a diverse range of key stakeholders from maternity units and universities throughout the country, and their support is instrumental to the success of the Centre. With the support of this group, we have developed the NPEC Data Access Policy for researchers wishing to access anonymised data currently maintained in the NPEC.

Lastly, I would like to thank the staff of the NPEC for their hard work and dedication to the mission of the Centre. Assessing the outcomes of maternity care provided, learning from the data and working together, we have great potential to improve the care of mothers and babies in Ireland. On behalf of all the staff at the NPEC, we look forward to a challenging and fruitful future.

Richard A Greene, Director, NPEC

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Summary

This is the first national audit of severe maternal morbidity in Ireland. Between 1st January 2011 and the 31st December 2011, anonymised data on severe maternal morbidity were collected from 19 of the 20 maternity units in Ireland (this includes one private and 18 public maternity units). In total, 67,806 maternities were reported from the 19 participating maternity units, representing 93% of maternities in Ireland for the calendar year 2011. Severe maternal morbidity was classified as the presence of one or more of 15 categories of maternal morbidity including: major obstetric haemorrhage (MOH), eclampsia, renal/liver dysfunction, cardiac arrest, pulmonary oedema, acute respiratory dysfunction, coma, cerebrovascular accident, status epilepticus, septicaemic shock, anaesthetic complications, pulmonary embolism, peripartum hysterectomy, admission to intensive care and interventional radiology. Major obstetric haemorrhage was defined as an estimated blood loss of ≥ 2,500ml, and or a transfusion of ≥ 5 units of blood and or documented treatment for coagulopathy. The methodology for case ascertainment and morbidity inclusion criteria, adapted by the National Perinatal epidemiology Centre (NPEC), was based on the Scottish Confidential Audit of Severe Maternal Morbidity (SCASMM) and are described in Appendix B. As such, use of this validated data collection tool with the kind permission of the Reproductive Health Programme of the National Health Service (NHS) Quality Improvement Scotland, facilitated international comparison with a relatively similar health care provision service and pregnant population. Although severe maternal morbidity may reflect the complexity of the pregnant population, evaluation of such cases has been acknowledged as a surrogate measure of quality care in the maternity services. Detailed findings of this audit are described throughout the body of this report with a summary of key findings outlined below:

Key findings

- Overall, 260 women were reported as experiencing at least one severe maternal morbidity, which translated as a national morbidity rate of 3.8 cases per 1,000 maternities or 1 in 263 maternities. This compares favourably with the most recent SCASMM report[1].

- The majority of women (57.7%) were diagnosed with one severe morbidity and one third (32.3%) were diagnosed with two severe morbidities. A small proportion was diagnosed with three or four morbidities.

- The perinatal mortality rate among women experiencing severe maternal morbidity was 32.6 deaths per 1,000 births. This was substantially higher than the national rate, which was estimated recently at 6.6 per 1,000 births[2].

- The incidence of severe maternal morbidity was disproportionately higher among ethnic minorities.

- Major obstetric haemorrhage (MOH) was the most frequent cause of severe maternal morbidity identified in 2011 with a reported rate of 2.3 per 1,000 maternities, followed by Intensive Care Unit (ICU) admission, renal/liver dysfunction and peripartum hysterectomy.

- Key findings and rates of women experiencing MOH mirrored findings from successive SCASSM reports. These include:

    - Uterine atony was the most frequently reported cause of MOH, followed by: other specific causes; retained placenta; and placenta praevia.

    - The majority of cases of MOH occurred in the postpartum period, with Caesarean section the most common associated mode of birth. MOH was also the most common

[1] Scottish Confidential Audit of Severe Maternal Morbidity: reducing avoidable harm. 9th Annual Report (2013). Available from:http://www.healthcareimprovementscotland.org/our_work/reproductive,_maternal__child/programme_resources/scasmm.aspx [Accessed: 12March 2013].

[2] National Perinatal Epidemiology Centre Annual Report 2011. Cork: NPEC, May 2012.

morbidity associated with ICU admission.

- Quality of care, as self-assessed by reporting units in cases of MOH, was reported as appropriate in the majority of cases with only a small proportion reporting minor issues of care potentially altering the outcome.

- The rate of peripartum hysterectomy was 0.3 per 1,000 maternities which is similar to findings in previous international studies[3,4]. The mode of birth in all cases where a hysterectomy was ultimately required was Caesarean section. The likelihood of women requiring a peripartum hysterectomy in the event of a MOH was increased when there was a history of previous Caesarean section; placenta praevia; and/or morbidly adherent placenta in this audit.

- One quarter of ICU admissions reported in this audit, (25.2%), were for reasons other than maternal morbidity. This may reflect resource issues in cases of maternal morbidity requiring intensive monitoring.

- The identified rate of eclampsia was 0.2 per 1,000 maternities and the rate of septic shock was 0.06 per 1,000 maternities. These findings are similar to those detailed in the SCASMM report[5] and the published literature.

[3] Murphy, CM, Murad, K, Deane, R, Byrne, B, Geary, MP, Mc Auliffe, FM. Severe maternal morbidity for 2004-2005 in the three Dublin maternity hospitals. Eur J Obstet Gynecol 2009: 143:34-37

[4] Kwee A, Bots ML, Visser GH, Bruinse HW. Emergency peripartum hysterectomy:a prospective study in The Netherlands. Eur J Obstet Gynecol Reprod Biol 2006;124(2):187–92

[5] Scottish Confidential Audit of Severe Maternal Morbidity: reducing avoidable harm. 9th Annual Report (2013). Available from:http://www.healthcareimprovementscotland.org/our_work/reproductive,_maternal__child/programme_resources/scasmm.aspx .

Recommendations

Based on the findings of this report, the NPEC makes the following recommendations:

- All maternity units should collect and submit anonymised complete data on severe maternal morbidity to inform the NPEC national audit on severe maternal morbidity.
- A multidisciplinary approach in case ascertainment is recommended to ensure all cases of severe maternal morbidity are captured. Involvement of obstetricians at a consultant level and senior midwives is recommended in the audit process.
- Cases of severe maternal morbidity should be notified through a clinical incident reporting or risk management system in all maternity units.
- Further research exploring factors leading to the identified higher maternal morbidity rate among minority ethnic groups is warranted.
- Counselling support should be available for all women and their partners following a severe maternal morbidity.
- Women with a suspected/diagnosed placenta praevia/morbidly adherent placenta are at high risk of MOH. There should be a documented consultant-led multi-disciplinary plan for delivery. A consultant obstetrician should be present at the delivery.
- All maternity units should ensure access to the national guidelines on the management of postpartum haemorrhage (PPH) including MOH[6]. Guidelines on maternal collapse should also be available across maternity and general units.
- Frequent multidisciplinary training in skills and drills programmes (including: maternal collapse and MOH) should be prioritised in all maternity units for all maternity care professionals at all levels.
- In the event of a MOH, early notification and involvement of senior members of the multidisciplinary team should be employed, including the haematology team.
- Accurate estimation and recording of blood loss remains a challenge. Methods of estimating blood loss are outlined in the national guidelines on the prevention and management of PPH. Local protocols and practices should be guided by same.
- Use of a specific proforma to document management during a MOH event is recommended. An example of such a proforma is included in Appendix C.
- For women at expected high risk of MOH, consideration should be given to the use of interventional radiology. The feasibility of providing such a service in all health service regions should be assessed.

[6] Clinical Practice Guideline No 17 (2012). Prevention and management of primary post partum haemorrhage. Institute of Obstetricians and Gynaecologists, Royal College of Physicians of Ireland and Directorate of Strategy and Clinical Programmes, Health Service Executive. Available at: http://www.rcpi.ie/Faculties/Pages/ClinicalPracticeGuidelinesinObstetricsandGynaecology.aspx

Severe Maternal Morbidity Surveillance in Ireland

Background

Historically, maternal mortality has been used as a measure of quality of care in maternity services. However, maternal mortality is now, fortunately too rare an event in developed countries to be used alone as a quality indicator. The evaluation of severe maternal morbidity is acknowledged as a useful complementary measure.

The term maternal morbidity encompasses the range of chronic and acute conditions that may result in obstetric complications during labour, delivery and the puerperium. However, given the lack of international consensus, defining severe maternal morbidity, also referred to as "near miss cases", is more difficult. Whereas some definitions have included management-based systems and an organ-based definition, others propose a morbidity continuum, beginning with health and normal pregnancy, moving along the spectrum of morbid events to death. This concept, described by Mantel *et al*.[7], conveys that maternal death only represents the 'tip of the iceberg' (Figure 1).

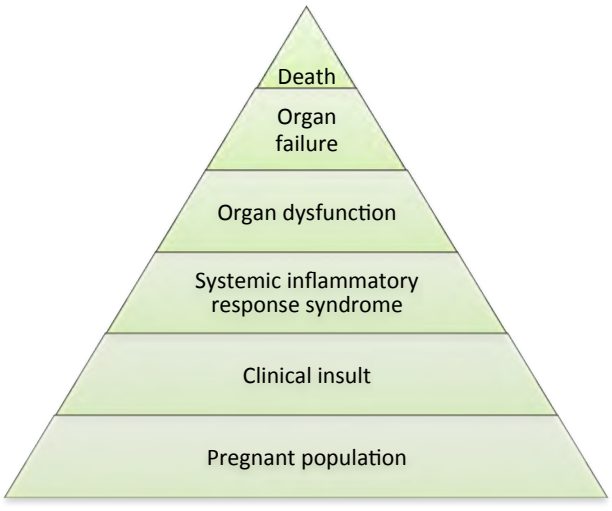


Figure 1: Mantel et al.'s[7] maternal morbidity continuum

In Ireland, increasing incidence rates for select maternal morbidities are cause for concern. For instance, research has shown that between 1999 and 2009, postpartum haemorrhage (PPH) rates have more than doubled (1999: 1.5%; 2009: 4.1%).[8] A significant increase in the rate of blood transfusion co-diagnosed with atonic PPH was also reported. Further, increasing Caesarean delivery rates have subsequently resulted in an increase in peripartum hysterectomy for morbidly adherent placenta.[9] Such findings underscore the importance of maternal morbidity audit to guide clinical practice, by examining aetiological factors, preventative measures and quality of care. However, to date, there has been no nationally representative data available on the incidence of severe maternal morbidity in Ireland.

In this context, the NPEC established the Maternal Morbidity Advisory Group (Appendix A) to assist in the investigation of severe maternal morbidity in Ireland through the provision of key epidemiological evidence. After reviewing the current evidence base, the NPEC and the Maternal Morbidity Advisory Group decided to establish an audit system modelled after the SCASMM. The NPEC would like to acknowledge with thanks the Reproductive Health Programme of the NHS Quality Improvement Scotland for permission to modify and use their Severe Maternal Morbidity Notification and Major Obstetric Haemorrhage forms for a similar audit in Ireland. Since 2003, the Reproductive Health Programme of Healthcare Improvement Scotland has conducted a national audit on severe maternal morbidity cases in Scotland, which has provided maternity healthcare professionals with critical clinical and epidemiological data on incidence, risk factors and changing trends in severe maternal morbidity.[10] Thus, the purpose of this audit is to

[7] Mantel GD,Buchmann E, Rees H, Pattinson RC. Severe Acute maternal morbidity: a pilot study of a definition for a near-miss. *BJOG* 1998; 105: 985-90.

[8] Lutomski J, Byrne BM, Devane D, Greene RA. Increasing trends in atonic postpartum haemorrhage in Ireland: an 11-year population-based cohort study. *BJOG* 2012; 119: 306-14.

[9] Turner MJ. Peripartum hysterectomy: an evolving picture. *Int J Gynaecol Obstet 2010*. 109(1): 9-11.

[10] NHS Quality Improvement Scotland. *Scottish Confidential Audit of Severe Maternal Morbidity 2008: 6th Annual Report 2010*; Edinburgh: NHS Quality Improvement Scotland.

provide baseline evidence for reflective practice and action planning by all maternity healthcare providers, public health professionals and policy makers in Ireland.

Methods

There are 20 maternity units in Ireland. Between January 1, 2011 and December 31, 2011, anonymised data on severe maternal morbidity cases were collected from 19 of the 20 units. One hospital chose not to provide data for this audit but it is expected that data on severe maternal morbidity will be provided by all units in future audits. For each severe maternal morbidity case, a designated midwife, obstetric consultant or specialist registrar completed the NPEC Severe Maternal Morbidity Notification Form (Appendix B). This is a validated data collection tool originally designed for the SCASMM. This form was subsequently adapted for the Irish population and contains minimal information on maternal and delivery characteristics. Maternal morbidity case inclusion criteria are described in detail at the end of the NPEC Severe Maternal Morbidity Notification Form. In brief, women may be reported as having one or more of 15 categories of maternal morbidity, i.e., MOH, eclampsia, renal/liver dysfunction, cardiac arrest, pulmonary oedema, acute respiratory dysfunction, coma, cerebrovascular accident, status epilepticus, septicaemic shock, anaesthetic complications, pulmonary embolism, peripartum hysterectomy, admission to intensive care and interventional radiology.

In the case of MOH (defined as blood loss ≥2,500ml, transfusion of ≥5 units of blood or documented treatment for coagulopathy), participating units were asked to complete a detailed case assessment using the Major Obstetric Haemorrhage Form (Appendix B).

The NPEC Severe Maternal Morbidity Notification Form and the Major Obstetric Haemorrhage Form are available for download on the NPEC website (http://www.ucc.ie/en/npec/projects/smm).

To ensure accuracy of information, missing or incomplete data was sought from respective maternity units.

In keeping with the international published literature, national rates per 1,000 maternities and corresponding 95% confidence intervals (95% CI) were calculated for each severe morbidity category[11]. Denominator data on the number of maternities (number of births, live and stillbirths) were provided directly by individual maternity units.

To determine if any unit's overall severe maternal morbidity rates significantly deviated from the national average, rates for all contributing units were graphed on a funnel plot. Funnel plots discourage inappropriate ranking of units, and thus are a useful alternative for comparative analyses.[12] To interpret the funnel plot, individual unit severe maternal morbidity rates, the national rate and 95% confidence intervals around the national rate according to unit size were graphed. Maternity units with maternal morbidity rates lying outside the 95% confidence intervals were considered statistically different from the national rate (Figure 2, Figure 3).

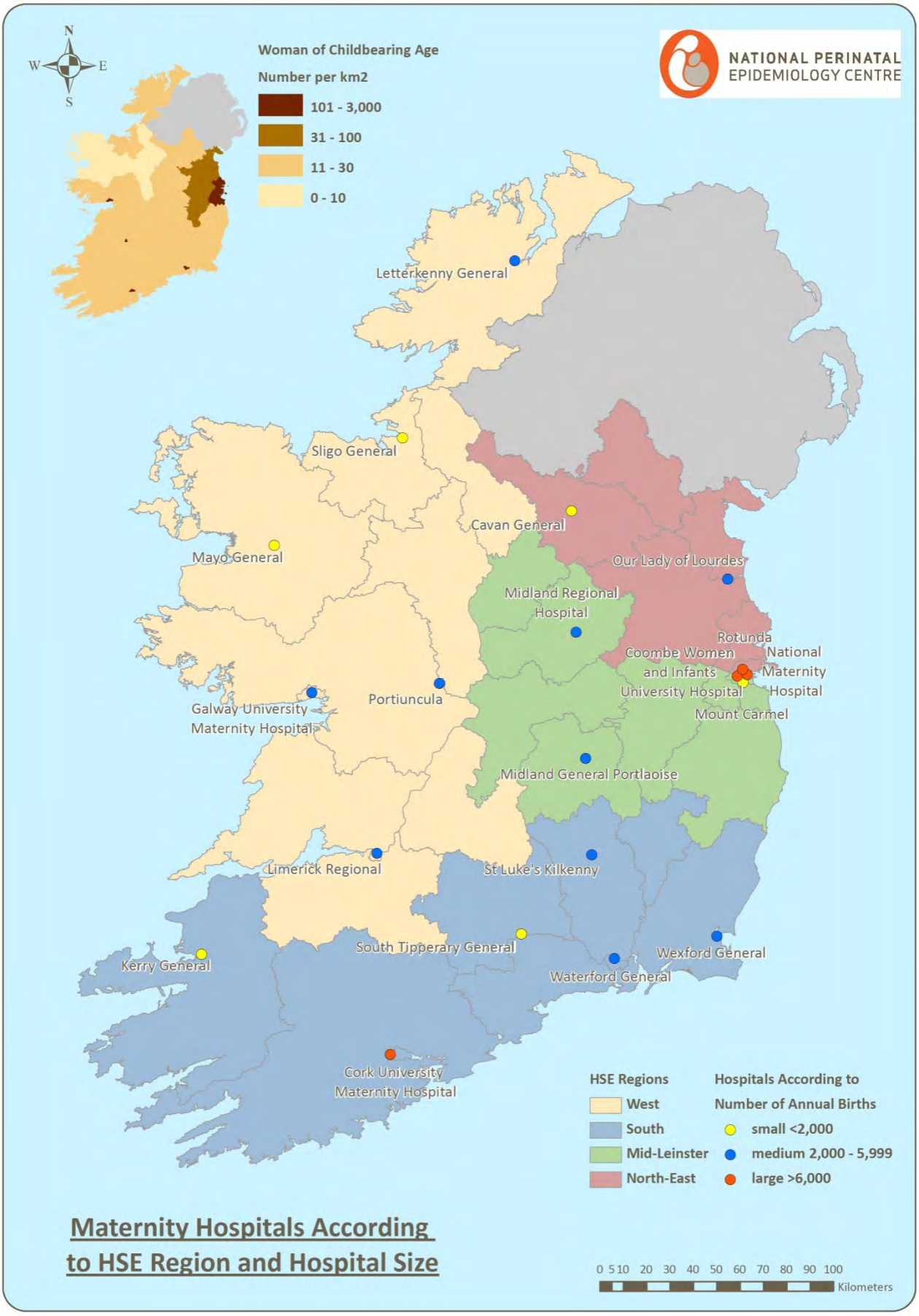
Severe maternal morbidity was examined across maternal age, ethnicity, parity and mode of delivery, as well as infant birthweight, and gestational age. Clinical characteristics associated with MOH were also explored. An in-depth review of MOH was undertaken across a range of clinical factors.

For analysis purposes, cases with missing data were excluded from calculations. However, ther extent of missing data is reported in the Results section.

All analyses were conducted using SPSS (Version 20.0).

[11] Agresti A, Coull BA. Approximate is better than "exact" for interval estimation of binomial proportions. *Am Stat* 1998;52:119-26

[12] Spiegelhalter D. Funnel plots for institutional comparison. *Quality and Safety in Health Care* 2002; 11(4):390-91.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W
E
S
Woman of Childbearing Age
Number per km2
101 - 3,000
31 - 100
11 - 30
0 - 10
NATIONAL PERINATAL EPIDEMIOLOGY CENTRE
Letterkenny General
Sligo General
Cavan General
Mayo General
Our Lady of Lourdes
Midland Regional Hospital
Rotunda
Coombe Women and Infants University Hospital
National Maternity Hospital
Mount Carmel
Portiuncula
Galway University Maternity Hospital
Midland General Portlaoise
Limerick Regional
St Luke's Kilkenny
South Tipperary General
Wexford General
Waterford General
Kerry General
Cork University Maternity Hospital
HSE Regions
West
South
Mid-Leinster
North-East
Hospitals According to Number of Annual Births
small <2,000
medium 2,000 - 5,999
large >6,000
0 5 10 20 30 40 50 60 70 80 90 100
Kilometers
Maternity Hospitals According to HSE Region and Hospital Size

Results

Maternal morbidity incidence

In 2011, 67,806 maternities were reported from the 19 participating maternity units, representing 93% of maternities in Ireland for the calendar year 2011. Overall, 260 women were reported as having at least one severe maternal morbidity, which translated to a national morbidity rate of 3.8 cases per 1,000 maternities. The majority of women (57.7%; n=150) were diagnosed with one severe event and one-third (32.3%; n=84) were diagnosed with two severe events. A small proportion of women were diagnosed with three (8.8%, n=23) or four (1.2%; n=3) morbidities. Thus, 399 total events were observed (Table 1).

Major obstetric haemorrhage was the most frequently reported event (2.3 cases per 1,000 maternities), followed by admission into an intensive care unit (ICU), renal or liver dysfunction and peripartum hysterectomy.

Of the 111 women admitted to ICU, one-quarter (25.2%; n=28) had no associated severe morbidity as defined in this audit. As such this may reflect resource issues in cases where women required intensive monitoring. Notably, more than half of women (54.1%; n=60) admitted to ICU had a MOH.

The severe maternal morbidity rate ranged from 0 to 10.7 per 1,000 maternities for individual units. Rates of MOH, the most frequently reported morbidity, ranged from 0 to 5.4 per 1,000 maternities. Differences in the incidence of overall severe morbidity and MOH between units were identified (Figure 2, Figure 3).

In the funnel plots, the solid lines represent the national severe maternal morbidity rate and the national MOH rate (3.8 and 2.3 cases per 1,000 maternities respectively), and the dashed lines represent the 95% CI around the national rate according to unit size. In 2011, the severe maternal morbidity rates of three units fell outside the 95% CI; one unit had a statistically higher rate of MOH. **However, differences between units must be interpreted with caution, as they may not reflect care given, but rather differences in reporting accuracy in this early phase of the national audit.** Further, women at high risk for a morbid event are more likely to be referred and/or transferred to a tertiary hospital, which may impact on variances in rates between tertiary referral hospitals and secondary hospitals.

Table 1: Frequency and corresponding rates, 2011, 19 maternity units

Event	Frequency	Rate per 1,000 (95% CI)
Major obstetric haemorrhage	159	2.3 (1.9-2.7)
ICU/coronary care unit admission	111	1.6 (1.3-1.9)
Renal or liver dysfunction	26	0.4 (0.2-0.5)
Peripartum hysterectomy	23	0.3 (0.1-0.3)
Pulmonary embolism	12	0.2 (0.1-0.3)
Eclampsia	12	0.2 (0.1-0.3)
Pulmonary oedema	8	0.1 (0.04-0.20)
Cardiac arrest	7	0.1 (0.04-0.20)
Anaesthetic problem	7	0.1 (0.04-0.20)
Cerebrovascular event	6	0.09 (0.02-0.16)
Acute respiratory dysfunction	5	0.07 (0.01-0.11)
Septicaemic shock	4	0.06 (0.00-0.10)
Status epilepticus	3	0.04 (0.00-0.09)
Coma	--	--
Interventional radiology		
Planned	8	0.1 (0.04-0.20)
Unplanned	8	0.1 (0.04-0.20)
Total events reported	**399**	**3.8 (3.36-4.30) ***

*Total rate is based on the number of women diagnosed with a severe morbidity, not on the number of events.

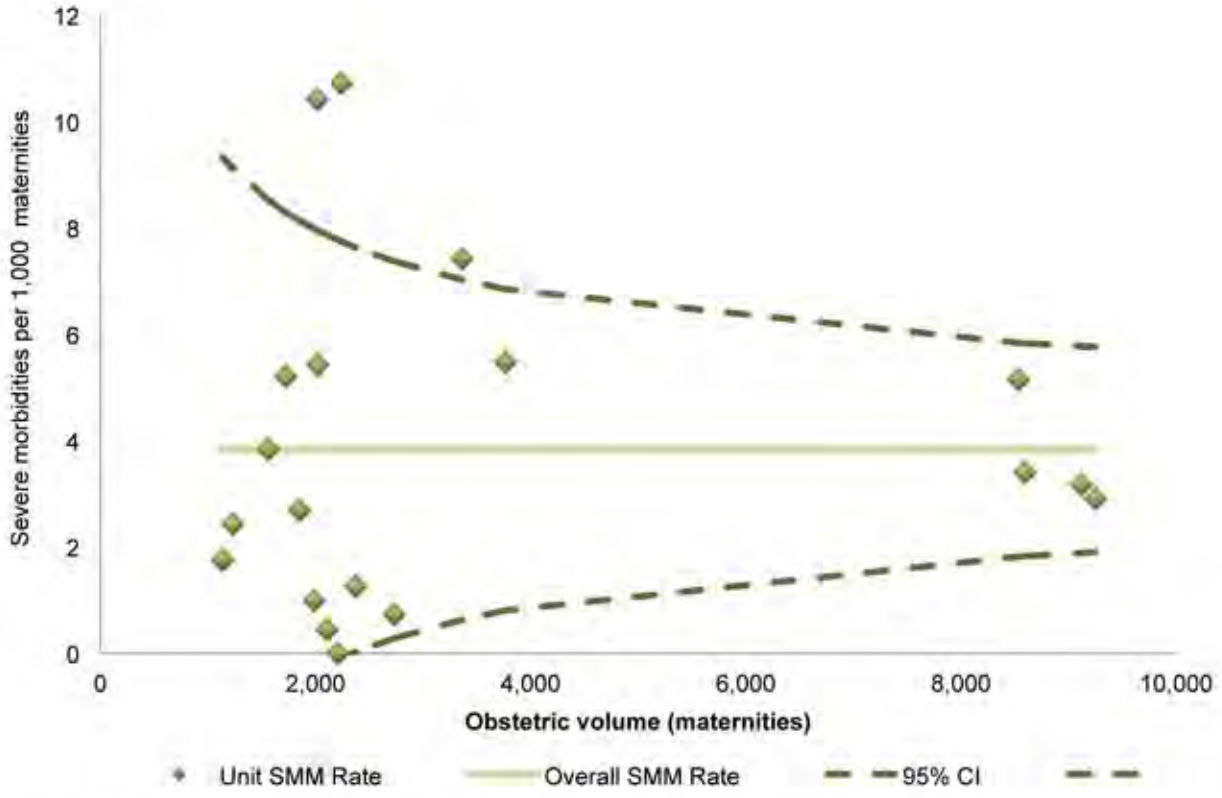

Figure 2: Funnel plot of severe maternal morbidity rates, 19 Irish maternity units, 2011

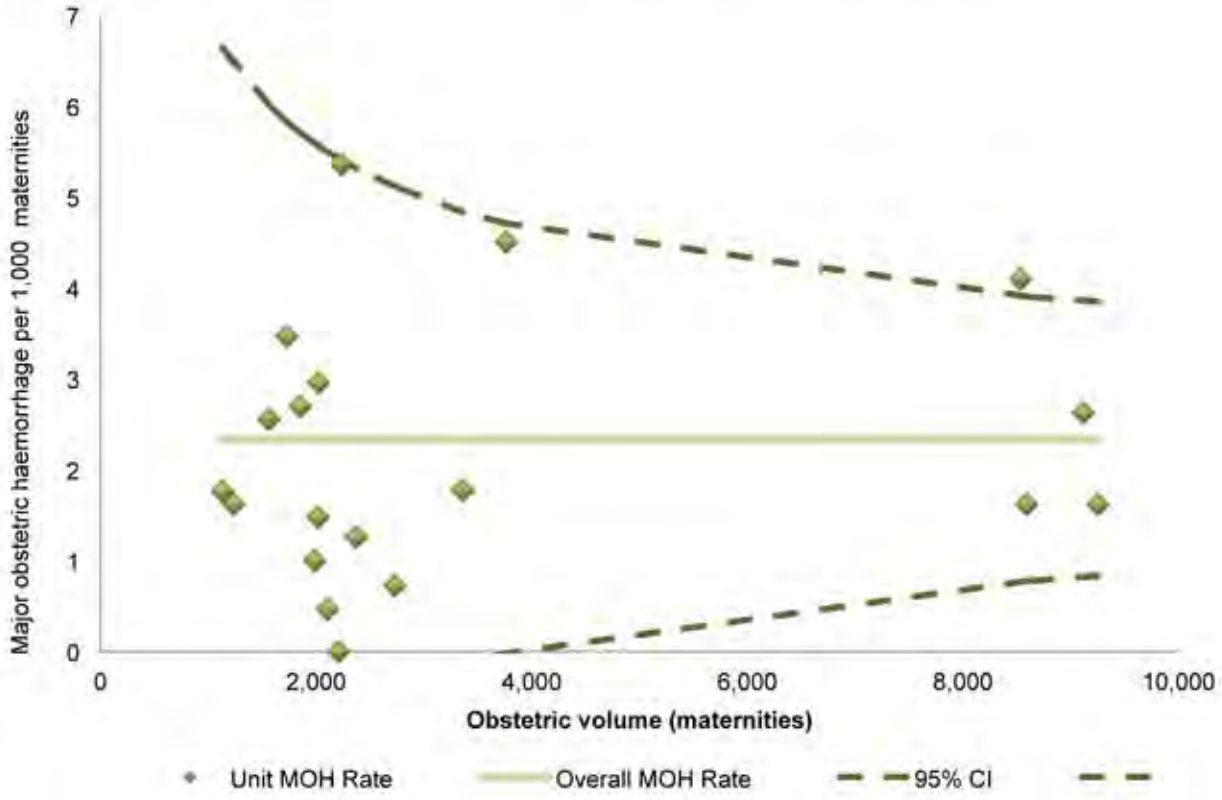

Figure 3: Funnel plot of major obstetric haemorrhage rates, 19 Irish maternity units, 2011

Overall maternal characteristics

Maternal age ranged from 16 to 45, with an average age of 32 (SD 6). Only two cases did not report on maternal age.

According to the 2011 Census, less than 1% of the Irish population reported being Irish Travellers, less than 2% Asian/Asian Irish and less than 2% Black/Black Irish.[13] However, women in these ethnic groups were disproportionately represented in this audit (Table 2). Data on ethnicity were missing for 54 women.

Table 2: Comparison of the ethnic distribution in the Severe Maternal Morbidity Audit Versus the Census

Ethnicity	2011 NPEC SMM %	2011 Census %
White Irish	70.4	85.8
Irish Traveller	2.9	0.7
Other white background	12.1	9.3
Asian/Asian Irish	7.8	1.9
Black/Black Irish	5.8	1.4
Other/mixed	1.0	0.9

Note: SMM, Severe Maternal Morbidity Audit

Table 3: Comparison of weight distribution in the 2011 Severe Maternal Morbidity Audit versus the 2007 Survey of Lifestyle, Attitudes and Nutrition

BMI Category (kgm^{-2})	2011 NPEC SMM %	2007 SLÁN %
Underweight (<18.5)	1.1	2
Healthy (18.5 - 24.9)	36.4	44
Overweight (25.0 - 29.9)	36.4	31
Obese (>30.0)	26.1	23

Note: SMM, Severe Maternal Morbidity Audit; SLÁN, Survey of Lifestyle, Attitudes and Nutrition

The majority of women were either overweight or obese (Table 3). The weight distribution among these women was slightly heavier than figures reported for women from the general population in the 2007 Survey of Lifestyle, Attitudes and Nutrition (SLÁN).[14] These findings must be interpreted in consideration of weight gain due to pregnancy. Data on body mass index (BMI) was missing for more than one quarter of women (29.2%; n=76).

One in eight women reported smoking at booking; few reported drinking at booking (Table 4). Only two women (1.0%) were recorded as having a documented history of drug abuse. Data were missing for 71 cases (27.3%) on smoking status at booking and for 93 cases (35.8%) on drinking status at booking.

Table 4: Reported frequency of smoking and alcohol use at booking

Maternal characteristics	%
Smoking at booking	13.2
Alcohol at booking	7.2

Nearly half of women were nulliparous (Table 5) and almost one-quarter were Para 1. Data on parity were missing for four cases (1.5%). An important finding was the over representation of women of higher parity, i.e. para 3+, experiencing severe maternal morbidity (16.4%) compared with their expected rate in the overall population (9.1%)[15].

Gestational age at onset of morbidity ranged between seven and 42 weeks. The majority of cases occurred among term pregnancies; few were reported at less than 24 weeks gestation (Table 6). Data on gestation were missing for 13 women.

Some 7.2% of women (n=16) were carrying a multiple gestation. There were 15 twin pregnancies and one triplet pregnancy. In 37 cases (14.2%), the number of gestations was not reported.

Table 5: Distribution of parity

Parity	%
Nulliparous	44.5
Para 1	22.7
Para 2	16.4
Para 3+	16.4

Table 6: Gestational age at onset of morbidity

Gestational age in completed weeks	%
<20	3.2
20 to <24	1.2
24 to <28	2.4
28 to <35	13.8
35 to <37	13.0
37 to <42	65.2
42	1.2

[13] Central Statistics Office. Profile 7 Religion, Ethnicity and Irish Travellers. 2012. Dublin: The Stationary Office.

[14] Harrington J, Perry I, Lutomski J, Morgan K, McGee H, Shelley E, Watson D, Barry M. *Survey of Lifestyle, Attitudes and Nutrition in Ireland: Dietary Habits of the Irish population*. 2008. Dublin: The Stationary Office.

[15] Economic and Social Research Institute Perinatal Statistics Report 2011 (December 2012).National Perinatal Reporting System.Dublin: ESRI.

Most women with a severe maternal morbidity were delivered via Caesarean section (Table **7**). One fifth of women had a spontaneous vaginal delivery. While there were no data on mode of delivery for 12 cases (4.6%), most of these (8 of 12) occurred in cases where the gestational age was less than 20 weeks and likely not applicable.

Table 7: Primary mode of delivery

Mode	%
Spontaneous vaginal	21.4
Assisted vaginal breech	--
Ventouse	9.3
Non-rotational forceps	3.2
Rotational forceps	--
Elective LSCS (no labour)	22.2
Elective LSCS (labour)	1.2
Emergency LSCS (no labour)	23.8
Emergency LSCS (labour)	19.0
Classical caesarean section	--

Note: LSCS, Lower segment caesarean section

Infant characteristics

Overall, 44 of the 260 women with a severe maternal morbidity were either diagnosed with a miscarriage or had substantial missing data on birth characteristics; these cases were excluded from the following analyses. Among the 216 mothers with data, there were 200 singleton births, 15 twin births and one triplet birth, resulting in a total of 233 infants. Approximately one-third of infants were transferred to the Special Baby Care Unit (SBCU) or Neonatal Intensive Care Unit (NICU) (Table 8). Data on perinatal outcome were available for 215 infants (7.7% missing). Overall, there were seven perinatal deaths, which translated to a rate of 32.6 deaths per 1,000 infants born to women with severe morbidity. This perinatal mortality rate was substantially higher than the national rate, which was recently estimated at 6.6 per 1,000 births.[16]

Infant birthweight was missing for only one infant (0.4%). Infant birthweight ranged from 540g to 5,050g with an average birthweight of 3,076g (SD: 836g). The distribution of infant birth weight by gestational age can be seen in Figure 4.

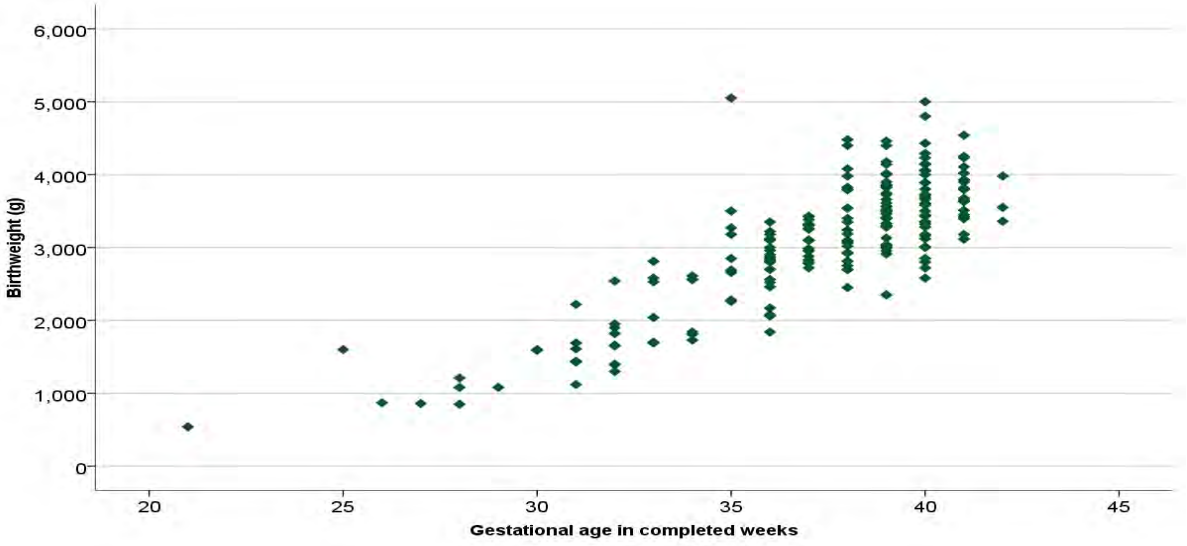

Figure 4: Birthweight by completed week's gestation

[16] National Perinatal Epidemiology Centre Annual Report 2011. Cork: NPEC, May 2012.

Table 8: Select neonatal outcomes by number of gestations

	Singleton infants (N=200)	Twin infants (N=30)	Triplet infants (N=3)	Total infants (N=233)
Intubation following delivery (%)	8.4	0.0	100.0	8.7
Transfer to SBCU/NICU (%)	35.9	28.6	100.0	35.9

Note: SBCU, Special Baby Care Unit; NICU, Neonatal Intensive Care Unit. Data on intubation were missing for 11.2% of infants; data on transfer to SBCU/NICU were missing for 15.0% of infants. Missing cases have been excluded from these calculations.

Major obstetric haemorrhage

Characteristics of event

Detailed case assessments were returned for the 159 women with a MOH; maternal characteristics are described in Appendix D. The most frequently reported cause of MOH was uterine atony, followed by other specified causes, retained placenta and placenta praevia (Table 9).

Table 9: Reported causes of major obstetric haemorrhage

Cause	N (%)
Uterine atony	68 (42.8)
Other specified causes	33 (20.8)
Retained placental membranes	27 (17.0)
Placenta praevia	20 (12.6)
Morbidity adherent placenta	17 (10.7)
Bleeding from uterine incision	17 (10.7)
Vaginal laceration	11 (6.9)
Abruption	14 (8.8)
Cervical laceration	4 (2.5)
Broad ligament haematoma	2 (1.3)
Uterine inversion	1 (0.6)
Uterine rupture	1 (0.6)

Note: Categories are not mutually exclusive and may add up to over 100%.

Most reported MOH cases occurred during the postpartum period (63.9%; n=99); one in five occurred intrapartum (20.0%; n=31). Some 12.9% (n=20) occurred antepartum, and 3.2% (n=5) occurred at less than 20 weeks gestation. Data on onset of haemorrhage were missing for four cases (2.5%). Cases of MOH occurred predominately in consultant-led units in keeping with the profile of most births in Ireland occurring in these units (Table 10). Timing of the event was most likely between 09.00 hours and 17.00 hours (Appendix D; Figure 6).

Table 10: Onset and location of haemorrhage

Cause	Consultant-led unit	Along-side midwife-led	At home
Early pregnancy (<20 weeks)	1	0	1
Antepartum	19	0	0
Intrapartum	29	1	0
Postpartum	93	0	2
Total	**142**	**1**	**3**

Note: Data missing for 13 cases (8.2%).

Two thirds of women experiencing MOH (67.1%) were delivered by caesarean section (Table 11). One fifth of women had a spontaneous vaginal delivery.

Table 11: Primary mode of delivery among women with a major obstetric haemorrhage

Mode	%
Spontaneous vaginal	20.4
Assisted vaginal breech	--
Ventouse	8.6
Non-rotational forceps	3.9
Rotational forceps	--
Elective LSCS (no labour)	24.3
Elective LSCS (labour)	2.0
Emergency LSCS (no labour)	19.1
Emergency LSCS (labour)	21.7
Classical caesarean section	--

Note: LSCS, Lower segment caesarean section. Data were missing for 7 cases.

Management of major obstetric haemorrhage

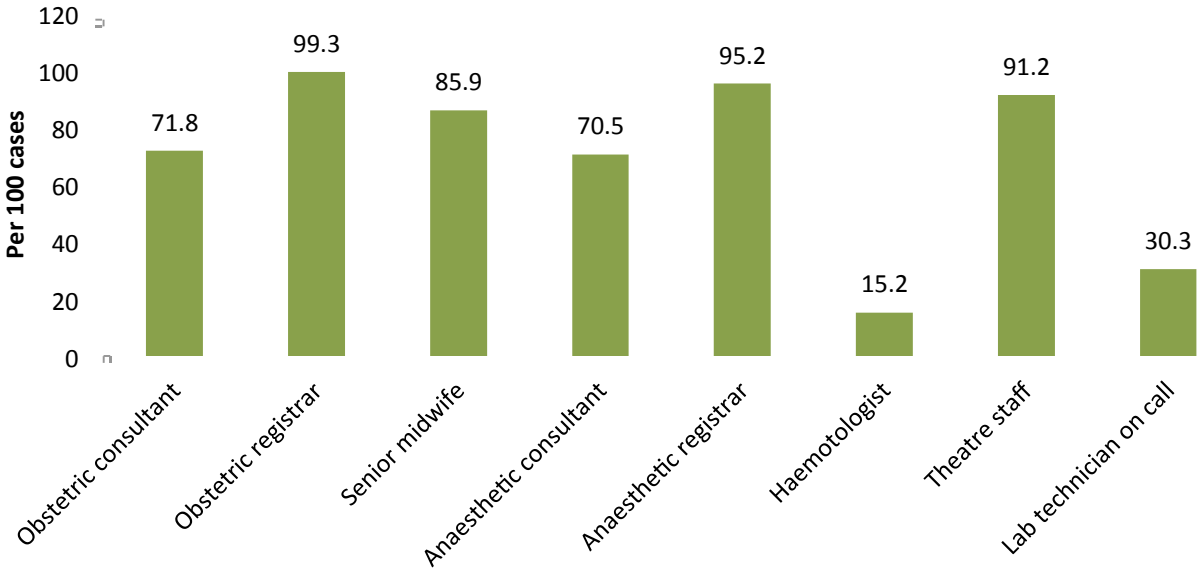

Figure 5: Percentage of major obstetric haemorrhage events by presence of Healthcare Professional Present

It is widely acknowledged that the management of MOH requires a multidisciplinary care approach with early direct consultant and senior staff involvement. Figure 5 outlines the reported presence of health professionals during management and care of MOH in this audit.

Successive reports of the SCASMM have underscored the importance of consultant involvement when a Caesarean delivery occurs at full cervical dilatation to prevent MOH. In 2011, an emergency Caesarean delivery at full cervical dilatation was reported for 10 women (6.7%). In seven of these cases (70.0%), a consultant obstetrician was present at the delivery; in the remaining three cases (30.0%) a consultant obstetrician was informed of the event.

In 23 cases of MOH, placenta praevia was known and/or morbidly adherent placenta was suspected. Elective caesarean was undertaken in nearly all cases and interventional radiology was used in approximately one third of cases (Table 12).

Table 12: Management of 23 suspected placenta praevia/ accreta

Action undertaken	N (%)
Elective Caesarean section planned	21 (91.3)
Obstetric consultant present at delivery	22 (95.7)
Interventional radiology undertaken	8 (35%)
Blood cell salvage was planned	--
Blood cell salvage occurred	--

Use of a prophylactic uterotonic agent was recorded for 46 of the 50 women (92.0%) with a vaginal delivery and 93 of the 102 women (91.2%) with a Caesarean delivery (Table 13). Among women delivering vaginally, 16 (32.0%) received more than one agent, while 26 (25.5%) received more than one agent following a Caesarean section.

Table 13: Prophylactic uterotonics administered post delivery

Uterotonic	Vaginal delivery N=50 N (%)	CS Delivery N=102 N (%)
Syntocinon	42 (84.0)	90 (88.3)
Syntometrine	11 (22.0)	11 (10.8)
Other†	10 (20.0)	21 (20.6)

†Includes ergometrine, misoprostol and carboprost.

Table 14 and Table 15; document the use of uterotonic agents for women with uterine atony and the incidence of haemostatic surgical procedures among women with MOH respectively. Data from the most recent SCASMM have also been included for comparative purposes[17] .

In both the Irish and the Scottish audits, practices appear to be similar in relation to the use of uterotonic agents in cases of uterine atony, with the exception of a higher reported use of Misoprostol in this audit. (Table14). The incidence of haemostatic surgical procedures among women with MOH was also similar in both reports although a higher rate of peripartum hysterectomy was identified in this Irish audit (Table 15).

Table 14: Uterotonic agent used among women with uterine atony: Ireland, SMM Audit 2011 (68 women) and Scotland, SMM data 2011 (184 women)[16]

Uterotonic	NPEC SMM 2011 N (%)	SCASMM SMM 2011 %
Syntocinon 5-10 units (IM/IV)	50 (73.5)	56%
Syntocinon infusion (40 units)	63 (92.6)	89%
Ergometrine 0.5mg (IM/IV)	22 (32.4)	55%
Syntometrine 5mg (IM)	22 (32.4)	NR
Carboprost 0.25mg (IM)	46 (67.6)	70%
Misoprostol 200 µg/mcg(PO/PV)	57 (83.8)	20%
Tranexamic acid 1g	6 (8.8)	NR

Note: Categories are not mutually exclusive and may add up to over 100%. NR: Not reported

[17] Scottish Confidential Audit of Severe Maternal Morbidity: 9th Annual Report (2013). Available from:http://www.healthcareimprovementscotland.org/our_work/reproductive,_maternal__child/programme_resources/scasmm.aspx .

Table 15: Incidence of haemostatic surgical procedures among women with MOH: Data from the NPEC Severe Maternal Morbidity Audit 2011 (159 women) and the 9th Annual report of the SCASMM in 2011 (349 women) [18]

Procedure	NPEC SMM 2011 Women undergoing procedure N (%)	NPEC SMM 2011: Hysterectomy ultimately required N (% of subcategory)	SCASMM SMM 2011 %
Intra-uterine balloon tamponade	47 (29.6)	8 (17.0)	24.9%
Manual removal of placenta/retained tissue	36 (22.6)	2 (5.6)	--
Repair of vaginal/cervical lacerations	33 (20.8)	1 (3.0)	--
Intra-myometrial carboprost	25 (15.7)	6 (24.0)	--
Hysterectomy	22 (13.8)	--	10%
Re-suturing caesarean section uterine incision and/or suturing of lateral extension	15 (9.4)	2 (13.3)	--
Haemostatic brace uterine suturing	12 (7.5)	2 (16.7)	6.6%
Bilateral ligation of uterine arteries	4 (2.5)	1 (25.0)	0.9%
Uterine artery embolization [Interventional Radiology]]	8 (5.0)	1 (12.5)	4.3%
Bilateral ligation of iliac arteries	1 (0.6)	1 (100.0)	0.9%

Note: Categories are not mutually exclusive and may add up to over 100%.

Data on blood transfusion were missing for five cases (3.1%). Types of transfusions and mean unit transfused are described in Table 16. In total, 144 women (93.5%) were reported as having received a blood transfusion; only one woman was a documented as 'refusing' blood products. Resuscitation and use of specialist equipment are described in Table 17.

Table 16: Type of transfusion and mean unit transfused

Type	Number of women transfused N (%)	Range transfused, units
Red blood cells		
"Emergency" O negative blood	39 (32.8)	1-9
Group specific uncross-matched blood	7 (6.4)	1-14
Cross-match blood	130 (94.9)	1-18
Blood products		
Fresh frozen plasma	30 (24.4)	1-16
Fibrinogen Concentrate	51 (40.2)	1-10
Platelets	46 (36.2)	1-8
Octoplas	63 (50.8)	1-16
Activated Factor VII	3 (2.6)	1-4

Note: Categories are not mutually exclusive and may add up to over 100%. Percentages based on cases with full data; for this reason, total N may vary.

Table 17: Resuscitation and use of specialist equipment

Action undertaken	N (%)
Venous access achieved	129 (100.0)
Two large venous cannulae sited	146 (95.4)
Oxygen given	143 (96.0)
Blood transfusion performed	144 (93.5)
Specialist equipment used to provide warm, rapid transfusion	79 (84.0)

Note: Percentages based on cases with full data only; for this reason, total N may vary.

[18] Scottish Confidential Audit of Severe Maternal Morbidity: 9th Annual Report (2013). Available from:http://www.healthcareimprovementscotland.org/our_work/reproductive,_maternal__child/programme_resources/scasmm.aspx .

Table 18: Monitoring of patients

Action undertaken	N (%)
Obstetric early warning chart	67 (44.7)
Blood pressure monitored (at least every 15 minutes)	153 (99.4)
Pulse monitored (at least every 15 minutes)	153 (99.4)
Pulse oximeter used	153 (99.4)
Foley catheter in-situ	154 (100.0)
Urine output measured regularly	144 (93.5)
Central venous pressure line	29 (19.5)
Arterial line	89 (58.9)

Note: Percentages based on cases with full data only; for this reason, total N may vary.

Quality of care in major obstetric haemorrhage

The detailed MOH questionnaire requests each unit to self-assess quality of care provided. In 85.8% of cases (n=97), the care given was reported as appropriate; 9.7% (n=11) reported that lessons could be learned. A small proportion (4.4%; n=5) reported that minor care issues occurred, where different management may have resulted in a different outcome. Data on the classification of management was missing/omitted for 46 cases (28.9%). These viewpoints were either based on consensus at a risk management meeting (35.2%), clinical case presentation (24.1%), informal clinical discussion (22.2%) or personal opinion (18.5%).

A time delay in access to theatre was reported for only one case of MOH; the approximate wait time was 30 minutes. Nearly all units (94.7%) stated that their unit has a protocol for the management of MOH, and in most cases (94.8%); staff reacted according to its unit's protocol. Although the use of obstetric early warning charts was reported in less than half of the cases, the majority of cases reported frequent monitoring of parameters (Table 18). Parameters may have been recorded on flow charts such as high dependency charts. The use of modified early obstetric warning scores (MEOWS) has been recommended and is of value in identifying impending maternal collapse[19] .

[19] Lewis G (ed) (2011). '*Saving Mother's Lives*: Reviewing maternal deaths to make motherhood safer: 2006-2008', Centre for Maternal and Child Enquiries (CMACE), 118 supplement 1: March 2011

Data on whether the case was discussed at a risk management meeting were available for 103 cases. Of these, 52.4% (n=54) were discussed at a risk management meeting, 37.9% (n=34) were not and 9.7% (n=10) were pending at the time of the submission of the form.

Summary of learning points described by units

Seven of the reporting units described in detail examples of both good practice and learning points gleaned in assessment of individual MOH cases. Recurrent reported themes are summarised below:

Identified positive practices

- Early detection of high risk cases and documented management plan for such cases.
- Multidisciplinary approach with good interdisciplinary communication.
- Early consultant and senior staff involvement.
- Counselling support for women and partners following a severe maternal morbidity.

Learning points

- Absence of documented management plan for some high risk cases.
- Lack of consideration of interventional radiology in some high risk cases where access to such a procedure was appropriate and available.
- Early recognition of post-partum haemorrhage and prompt treatment.
- Accurate estimation and recording of blood loss.
- Use of a specific proforma to document management during a MOH event.

- The importance of clear communication between the obstetric and haematology teams.
- Familiarity of all staff with the local protocol for management of MOH.
- The essential need for on-going multidisciplinary skills and drills programmes for all maternity care professionals.
- Dissemination of key learning points following an adverse event to all staff through structured forums.

Peripartum hysterectomy

There were 23 peripartum hysterectomies reported by the participating units in 2011, which translated to a rate of 0.3 per 1,000 maternities. This is similar to rates found in previous Irish and International studies[20,21,22]. There was no clustering of cases identified in any one hospital.

All but one case were associated with women experiencing a MOH, as defined in this audit, which gave a peripartum hysterectomy rate of 13.8% in the MOH cohort. This is higher than the rate of 10% reported in the most recent SCASSM report[23]. However, caution in interpretation of results must be exercised as the denominator of MOH may be underreported in this audit which would impact on these findings. The Scottish experience has identified an association between an increase in reported MOH and use of haemostatic surgical procedures with a significant decline in the rate of peripartum hysterectomies, (from 15.1% in 2003 to 5.6% in 2010), in women experiencing MOH over this seven year period[24].

The mode of delivery in all cases of women experiencing MOH who ultimately required a peripartum hysterectomy was Caesarean section, with the majority of operative deliveries being carried out prior to the onset of labour (Table 19).

Table 19: Mode of delivery in women experiencing major obstetric haemorrhage and peripartum hysterectomy

Mode of delivery	Number of cases	%
Vaginal delivery	0	0
Elective LSCS not in labour	10	45.5
Emergency LSCS not in labour	8	36.4
Emergency LSCS in labour	4	18.1
Total†	**22**	

† Note one case of peripartum hysterectomy did not meet the criteria of MOH, as defined in this audit, but was reported as a documented placenta accreta (Peripartum hysterectomy, n=23 cases)

Of the four women delivered by emergency LSCS in labour who required a hysterectomy, three of the operative deliveries were performed at full dilatation. Uterine atony was the reported cause of haemorrhage in two cases with a further two causes being attributed to bleeding from the uterine incision and post-partum endometritis respectively

Women experiencing a MOH who were delivered by LSCS prior to labour and ultimately required a hysterectomy were more likely to have a history of a previous Caesarean section; and/or the presence of a morbidly adherent placenta or placenta praevia. Within this cohort, 16 (88.9%) had a previous Caesarean section; six (33.3%) had one previous Caesarean section; four (22.2%) had two previous Caesarean section; and six (33.3%) had three or more previous Caesarean section (Table 20). The majority of women requiring peripartum hysterectomy were diagnosed as having a morbidly adherent placenta (61.1%) with a further 16.7% being diagnosed with a placenta praevia (Table 21). Other causes of MOH in this cohort included cervical cancer; cervical pregnancy and infection.

[20] Murphy, CM, Murad, K, Deane, R, Byrne, B, Geary, MP, Mc Auliffe, FM. Severe maternal morbidity for 2004-2005 in the three Dublin maternity hospitals. Eur J Obstet Gynecol 2009: 143:34-37

[21] Kwee A, Bots ML, Visser GH, Bruinse HW. Emergency peripartum hysterectomy:a prospective study in The Netherlands. Eur J Obstet Gynecol Reprod Biol 2006;124(2):187–92

[22] Knight M, Kurinczuk JJ, Spark P and Brocklehurst P. United Kingdom Obstetric Surveillance System (UKOSS) Annual Report 2007. National Perinatal Epidemiology Unit, Oxford.

[23] Scottish Confidential Audit of Severe Maternal Morbidity: reducing avoidable harm. 9th Annual Report (2013). Available from:http://www.healthcareimprovementscotland.org/our_work/reproductive,_maternal__child/programme_resources/scasmm.aspx .

[24] Scottish Confidential Audit of Severe Maternal Morbidity: reducing avoidable harm. 8th Annual Report (2012). Available from:http://www.healthcareimprovementscotland.org/our_work/reproductive,_maternal__child/programme_resources/scasmm.aspx .

Table 20: Number of previous caesarean sections in women delivered by LSCS prior to labour who required a hysterectomy following major obstetric haemorrhage

Number of previous caesarean sections	Number of cases	%
None	2	11.1
One	6	33.3
Two	4	22.2
Three or more	6	33.3
Total	**18**	

Table 21: Cause of major obstetric haemorrhage in women delivered by LSCS prior to labour requiring a hysterectomy

Cause of haemorrhage	Number of cases	%
Morbidly adherent placenta	11	61.1
Placenta praevia	3	16.7
Other cause	4	22.2
Total	**18**	

Management of major obstetric hemorrhage in women who ultimately required a peripartum hysterectomy

Of the 23 women in this audit who required a peripartum hysterectomy, 22 women were reported as experiencing a MOH. Within this cohort, in all cases of known placenta praevia/morbidly adherent placenta, a caesarean section was the planned mode of delivery and a LSCS was carried out by a consultant obstetrician prior to labour. In a small number of cases (n=3), a pre-delivery request for tubal ligation was reported which may have influenced decision making prior to preforming a hysterectomy.

Of the three women who were delivered by LSCS in labour at full cervical dilation, two were delivered by an obstetric registrar.

The incidence of haemostatic surgical procedures among women with a MOH who ultimately required hysterectomy has previously been illustrated (Table 15). Notably, within this small cohort of women, only two cases (4.5%) reported the use of haemostatic brace uterine suturing prior to performing a hysterectomy. In eight cases (36.4 %), the use of an intra-uterine balloon tamponade was employed. Interventional radiology was only carried out in one case of peripartum hysterectomy associated with MOH. However, it must be noted that currently, interventional radiology is a service that is not available in all health service regions.

Discussion

This is the first national audit of severe maternal morbidity in Ireland and these findings highlight the clear and inherent need for prospective audit. Although severe maternal morbidity may reflect the complexity of the pregnant population, evaluation of cases has been acknowledged as a surrogate measure of quality of care in the maternity services.

As previously described in this report, variations in definitions of severe maternal morbidity and criteria for identification of cases internationally impede comparative analysis between similarly resourced countries[25]. As such, one of the strengths of this national audit is the use of a validated data collection tool and methodology, based on the acknowledged on-going Confidential Severe Maternal Morbidity Audit in Scotland. This allows for comparison of maternal outcomes with a relatively similar healthcare provision service and pregnant population.

The rate of severe maternal morbidity found in this audit of 3.8 per 1,000 maternities is similar to findings from a previous Irish study[26] and compares favourably to a rate of 7.3 per 1,000 maternities as reported by SCASMM[27]. Similar to Scotland, we have found that MOH was the most frequently reported complication although a moderately lower rate was identified in this audit (2.3 versus 5.9 per 1,000 maternities). Uterine atony was found to be the most common underlying cause of MOH accounting for 42.8% cases. Caesarean section was the most frequent mode of delivery in women experiencing MOH with just one in five women having a spontaneous vaginal delivery. This mirrors findings from

[25] Say L, Pattinson RC, Gulmezoglu AM. WHO systematic review of maternal morbidity and mortality: the prevalence of severe acute maternal morbidity (near miss). Reprod Health 2004;1(1):3.

[26] Murphy, CM, Murad, K, Deane, R, Byrne, B, Geary, MP, Mc Auliffe, FM. Severe maternal morbidity for 2004-2005 in the three Dublin maternity hospitals. Eur J Obstet Gynecol 2009: 143:34-37

[27] Scottish Confidential Audit of Severe Maternal Morbidity: reducing avoidable harm. 9th Annual Report (2013). Available from:http://www.healthcareimprovementscotland.org/our_work/reproductive,_maternal__child/programme_resources/scasmm.aspx.

successive SCASMM reports. The increased likelihood of MOH occurring secondary to uterine atony identified in this audit highlights the importance of on-going multidisciplinary skills and drills programs and national guidelines[28] in the management of obstetric haemorrhage to ensure a standardised quality maternity service.

The peripartum hysterectomy rate of 0.3 per 1,000 maternities was similar to rates reported in previous Irish and International studies[29,30,31]. An association between peripartum hysterectomy, MOH, previous caesarean section and morbidly adherent placenta has been identified internationally[32,33]. Findings in this audit supported the likelihood of such an association in women experiencing MOH. In light of the increasing Caesarean section rates in Ireland from 21.9% in 2002 compared with 27.3% per maternities in 2011[34], this is an important finding. There is a potential for increasing rates of peripartum hysterectomy in future years if the rate of Caesarean section continues to rise. Maintaining or reducing the Caesarean section rate, including consideration of an active elective approach to vaginal birth after Caesarean section (VBAC), may alter this expectation. Another approach to reducing peripartum hysterectomy rates might include planned interventional radiology in women at high risk, e.g. women with a suspected morbidly adhered placenta and/or with a previous obstetric history of multiple Caesarean sections. Future, planning of maternity services should consider the provision of interventional radiology in all health service regions.

Admission to intensive care has been used as a surrogate marker for severe maternal morbidity internationally. Major obstetric haemorrhage was the most common morbidity associated with ICU admission in this audit. However, it was identified that one-quarter of ICU admissions had no associated severe morbidity, as defined in this audit, and as such may reflect resource issues in cases when women required intensive monitoring. From 2012 onwards, indication for ICU admission other than severe morbidity will be identified in the NPEC audit. This will provide useful baseline information for health service planners.

Variations between maternity units were noted in the reported incidence of severe maternal morbidities with one unit having a statistically higher rate of MOH as demonstrated in the funnel plot of MOH rates for the 19 Irish maternity units in 2011 (Figure 3). However, this may reflect varying degrees of case ascertainment, particularly in the identification of cases due to coagulation dysfunction, as outlined in the reporting criteria for MOH. Underreporting is a concern and has been the experience of other established confidential audits on severe maternal morbidity[35] . Since the 2011 audit was performed retrospectively, all severe maternal morbidity cases may not have been captured in maternity units. Nonetheless, from 2012 onwards, cases will be reported prospectively, which will likely decrease the risk of underreporting. Rates between tertiary referral hospitals versus secondary hospitals must also be interpreted with caution. Women at high risk for a morbid event are more likely to be referred and/or transferred to a tertiary hospital. For this reason, such units may report higher incidence rates of maternal morbidity.

The incidence of severe maternal morbidity was disproportionately higher among ethnic minorities.

[28] Clinical Practice Guideline No 17 (2012). Prevention and management of primary post partum haemorrhage. Institute of Obstetricians and Gynaecologists, Royal College of Physicians of Ireland and Directorate of Strategy and Clinical Programmes, Health Service Executive.

[29] Murphy, CM, Murad, K, Deane, R, Byrne, B, Geary, MP, Mc Auliffe, FM. Severe maternal morbidity for 2004-2005 in the three Dublin maternity hospitals. Eur J Obstet Gynecol 2009: 143:34-37

[30] Kwee A, Bots ML, Visser GH, Bruinse HW. Emergency peripartum hysterectomy:a prospective study in The Netherlands. Eur J Obstet Gynecol Reprod Biol 2006;124(2):187–92

[31] Knight M, Kurinczuk JJ, Spark P and Brocklehurst P. United Kingdom Obstetric Surveillance System (UKOSS) Annual Report 2007. National Perinatal Epidemiology Unit, Oxford.

[32] Turner MJ. Peripartum hysterectomy: an evolving picture. *Int J Gynaecol Obstet 2010*. 109(1): 9-11.

[33] Awan N, Bennett MJ, Walters WA. Emergency peripartum hysterectomy: a 10-year review at the Royal Hospital for Women, Sydney. Aust N Z J Obstet Gynaecol. 2011: Jun;51(3):210-5.

[34] Economic and Social Research Institute. (2012) Perinatal Statistics Report 2011. National Perinatal Reporting System. Dublin: ESRI.

[35] Scottish Confidential Audit of Severe Maternal Morbidity: reducing avoidable harm. 8th Annual Report (2010). Available from:http://www.healthcareimprovementscotland.org/our_work/reproductive,_maternal__child/programme_resources/scasmm.aspx.

This is an important finding in light of the recent reports of the Confidential Maternal and Child Enquiry (CMACE) in the UK[36] and the Maternal Death Enquiry (MDE) in Ireland[37], which had similarly found that ethnic minorities were at an increased risk of maternal death. Further research exploring potential differences in health seeking behaviours is warranted to ensure that all women understand the importance of accessing the high quality of obstetric care available in Ireland.

Quality of care as self-assessed by reporting units in cases of MOH was reported as appropriate in 85.8% of cases with only a small proportion (4.4%) reporting that minor issues of care potentially altered the outcome that occurred. While this is reassuring it must be acknowledged that not all professionals accept the validity of self-assessment. The small proportion of units describing learning points in detail is perhaps disappointing but nevertheless, lessons identified can be used on a national level to improve clinical care.

Several important limitations must be noted. Firstly, since the number of maternities (live- and stillbirths) were used to calculate the denominator, the rate of severe maternal morbidity may be overestimated. This arises because women at risk of severe maternal morbidity following molar/ectopic pregnancies and miscarriages will be underrepresented in the denominator. In the most ideal situation, the denominator would not only capture maternities resulting in birth but also miscarriages, ectopic pregnancies and molar pregnancies. However, this information was not available for all units, and therefore, to ensure uniformity in the analysis, the denominator was restricted to live- and stillbirth. Reassuringly, given the low frequency of multiple births, the SCASMM has reported minimal variation in rates calculated using births versus maternities.

Secondly, it is also acknowledged that this audit was carried out in maternity units: cases that presented in general adult hospitals may not have been identified by the obstetric team.

Lastly, in the case of perinatal deaths, reverse causation is possible. For instance, surgical treatment for an intrauterine death may ultimately result in a severe morbidity. Thus, the perinatal death would not be an outcome of the morbidity but rather an antecedent. Still, this form of bias would likely have minimal impact on the findings presented in this report.

In conclusion, this first national audit of severe maternal morbidity has provided important baseline information for healthcare professionals invested in improving maternity care in Ireland. Further, recording and assessment of cases of severe maternal morbidity is an integral part of continuing professional development for obstetricians, midwives and obstetric anaesthetists. Continued, national surveillance of severe maternal morbidity is a critical step in improving obstetric outcomes.

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[36] Lewis G (ed) (2011). Saving Mothers' Lives: Reviewing maternal deaths to make motherhood safer: 2006-2008, Centre for Maternal and Child Enquiries (CMACE), BJOG; 118 Supplement 1: March 2011.

[37] Confidential Maternal Death Enquiry in Ireland, Report for Triennium 2009-2011, Cork: MDE, August 2012. Available from: http://www.mdeireland.com/ .

Appendix A: Maternal Morbidity Advisory Group Members

Dr. Bridgette Byrne, Consultant Obstetrician/Gynaecologist, Coombe Women & Infants Hospital
Nominated by the Institute of Obstetricians & Gynaecologists, RCPI

Ms. Deirdre Daly, Lecturer in Midwifery**,** Trinity College Dublin
Nominated by Deputy Nursing Services Director, HSE

Prof. Declan Devane, Chair of Midwifery, School of Nursing and Midwifery, National University of Ireland, Galway
Nominated by Deputy Nursing Services Director, HSE

Prof. Michael Geary, Consultant Obstetrician/Gynaecologist, Rotunda Hospital
Nominated by the Institute of Obstetricians & Gynaecologists, RCPI

Dr. Miriam Harnett, Consultant Anaesthetist**,** Cork University Hospital
Nominated by the Irish College of Anaesthetists

Ms. Ita Kinsella, Clinical Midwife Manager 2**,** Midland Regional Hospital, Portlaoise
Nominated by Deputy Nursing Services Director, HSE

Ms. Janet Murphy, Advanced Midwife Practitioner**,** Waterford Regional Maternity Hospital
Nominated by Deputy Nursing Services Director, HSE

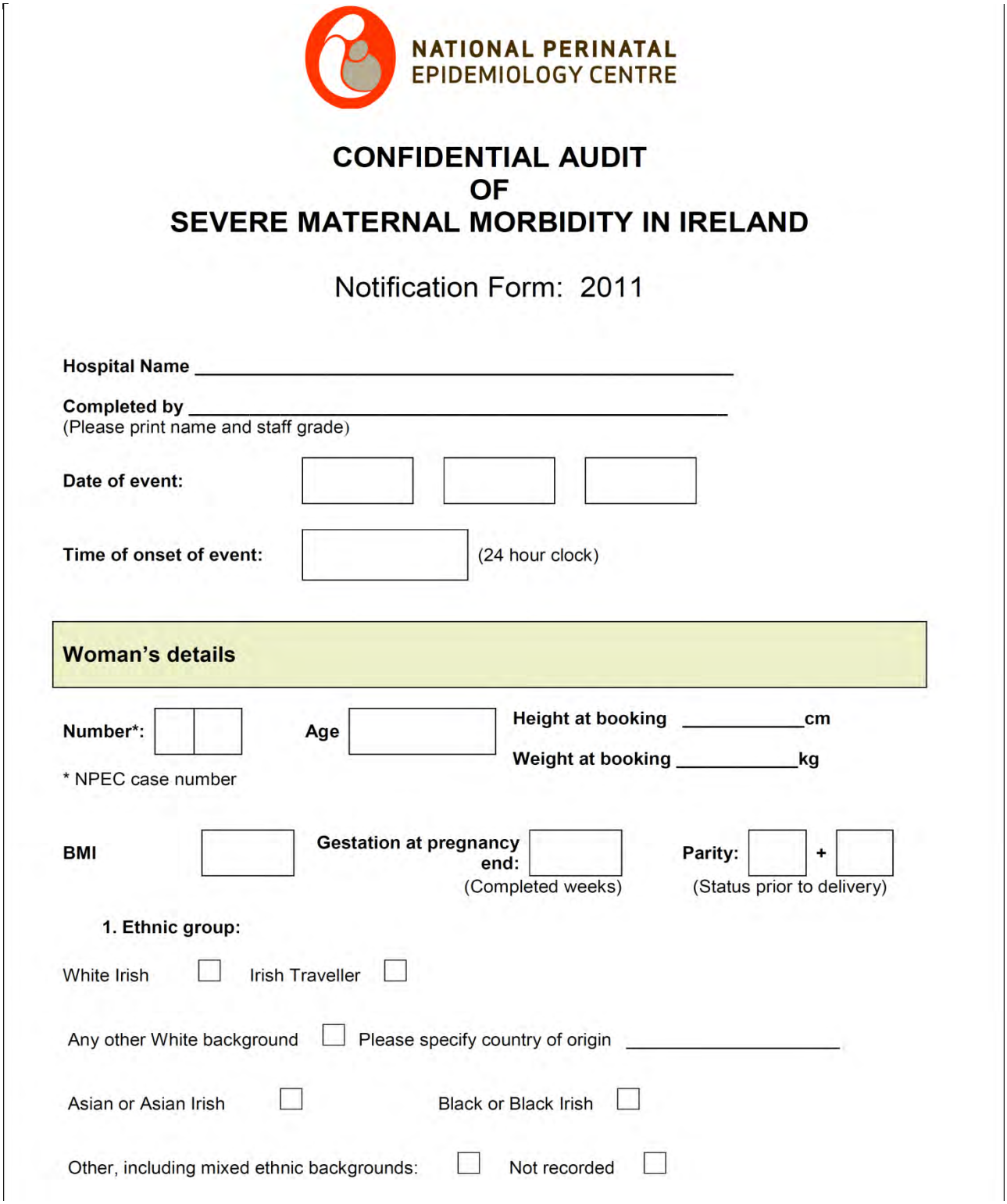
Dr. Ray O'Sullivan, Consultant Obstetrician/Gynaecologist**,** St. Luke's Hospital, Kilkenny
Nominated by the Institute of Obstetricians & Gynaecologists, RCPI

Prof. Richard Greene, Consultant Obstetrician/Gynaecologist, Cork University Maternity Hospital
Chair, Director of the National Perinatal Epidemiology Centre

Ms. Edel Manning, Research Midwife, National Perinatal Epidemiology Centre
Severe Maternal Morbidity Project Coordinator

Ms. Jennifer Lutomski, Epidemiologist, National Perinatal Epidemiology Centre
National Perinatal Epidemiology Centre Epidemiologist

Appendix B: NPEC Severe Maternity Morbidity Notification Form



NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

CONFIDENTIAL AUDIT OF SEVERE MATERNAL MORBIDITY IN IRELAND

Notification Form: 2011

Hospital Name _____

Completed by _____
(Please print name and staff grade)

Date of event: ☐☐ ☐☐ ☐☐☐☐

Time of onset of event: ☐☐☐☐ (24 hour clock)

Woman's details

Number*: ☐☐ **Age** ☐☐ **Height at booking** _____cm

Weight at booking _____kg

* NPEC case number

BMI ☐☐ **Gestation at pregnancy end:** ☐☐ (Completed weeks) **Parity:** ☐ + ☐ (Status prior to delivery)

1. Ethnic group:

White Irish ☐ Irish Traveller ☐

Any other White background ☐ Please specify country of origin _____

Asian or Asian Irish ☐ Black or Black Irish ☐

Other, including mixed ethnic backgrounds: ☐ Not recorded ☐

2.a. Did the woman smoke at booking? Yes ☐ please specify quantity _____

No ☐ Not recorded ☐

2b. Did she give up smoking during pregnancy? Yes ☐ No ☐ Not recorded ☐ N/A ☐

3. Did the woman drink alcohol at booking? Yes ☐ No ☐ Not recorded ☐

4. Is there documented history of drug abuse or attendance at a drug rehabilitation unit?

None recorded ☐ Prior to this pregnancy ☐ During this pregnancy ☐

Maternal Morbidity Category

(See page 4 for definitions)

Please tick all that apply

1. Major obstetric haemorrhage*		
2. Eclampsia		
3. Renal or liver dysfunction		
4. Cardiac arrest		
5. Pulmonary oedema		
6. Acute respiratory dysfunction		
7. Coma		
8. Cerebro-vascular event		
9. Status epilepticus		
10. Septicaemic shock		
11. Anaesthetic problem		
12. Pulmonary embolism		
13. Peripartum hysterectomy		
14. ICU/CCU admission		
15. Interventional radiology (IR)*	15a. Planned	
	15b. Unplanned	

* For categories 1 and 15, please complete the NPEC Major Obstetric Haemorrhage Audit Form

5. Mode of delivery:

	Baby 1	Baby 2*		Baby 1	Baby 2*
i) Spontaneous vaginal delivery	☐	☐	vi) Elective LSCS not in labour	☐	☐
ii) Assisted vaginal breech delivery	☐	☐	vii) Elective LSCS in labour	☐	☐
iii) Ventouse vaginal delivery	☐	☐	viii) Emergency LSCS not in labour	☐	☐
iv) Non-rotational forceps vaginal delivery	☐	☐	ix) Emergency LSCS in labour	☐	☐
v) Rotational forceps vaginal delivery	☐	☐	x) Classical Caesarean Section	☐	☐

Neonatal Outcome

Please tick all that apply

Baby Outcomes	Baby 1	Baby 2	Baby 3
Birth weight in grams			
Intubation following delivery (Yes/No)			
Transferred to SBCU/NICU			
*Early Neonatal Death			
*Late Neonatal Death			
Intrauterine death ≥ 500g			
*Miscarriage			

*Please refer to reference manual for definitions

Queries and form submission

The National Perinatal Epidemiology Centre (NPEC) is sincerely grateful for your contribution to this audit.

If you have questions or difficulties regarding any aspect of the form, please do not hesitate to contact the NPEC team by telephone: **021 4205017** or by email: **npec@ucc.ie**

Please submit completed forms to:
Coordinator: Edel Manning
Research Midwife
The National Perinatal Epidemiology Centre
Department of Obstetrics and Gynaecology
5th Floor, Cork University Maternity Hospital
Wilton
Cork

Maternal Morbidity Definitions		
1	Major obstetric haemorrhage	Estimated blood loss ≥ 2500ml, or transfused 5 or more units of blood or received treatment for coagulopathy (Fresh Frozen Plasma; Fibrinogen Concentrate Substitution Therapy; Platelets) (Also includes ectopic pregnancy meeting these criteria)
2	Eclampsia	Seizure associated with antepartum, intrapartum or postpartum symptoms and signs of pre-eclampsia
3	Renal or liver dysfunction	Acute onset of biochemical disturbance, urea >15mmol/l, creatinine>400mmol/l, AST/ALT >200u/l
4	Cardiac arrest	No detectable major pulse
5	Pulmonary oedema	Clinically diagnosed pulmonary oedema associated with acute breathlessness and O_2 saturation <95%, requiring O_2, diuretics or ventilation
6	Acute respiratory dysfunction	Requiring intubation or ventilation for >60 minutes (not including duration of general anaesthetic)
7	Coma	Including diabetic coma. Unconscious for >12 hours
8	Cerebro-vascular event	Stroke, cerebral/cerebellar haemorrhage or infarction, subarachnoid haemorrhage, dural venous sinus thrombosis
9	Status epilepticus	Constant or near constant state of having seizures that last 30mins or more
10	Septicaemic shock	Shock (systolic blood pressure <80) in association with infection. No other cause for decreased blood pressure. Pulse of 120bpm or more
11	Anaesthetic problem	Aspiration, failed intubation, high spinal or epidural anaesthetic
12	Pulmonary embolism	Increased respiratory rate (>20/min), tachycardia, hypotension. Diagnosed as "high" probability on V/Q scan or positive spiral chest CT scan. Treated by heparin, thrombolysis or embolectomy
13	Peripartum hysterectomy	Peripartum hysterectomy
14	ICU/CCU admission	Unit equipped to ventilate adults. Admission for one of the above problems or for any other reason. Includes CCU admissions
15a	Planned Interventional radiology	Received planned interventional radiology
15b	Unplanned Interventional radiology	Received unplanned interventional radiology

Acknowledgement
NPEC would like to acknowledge with thanks the Reproductive Health Programme of the National Health Service (NHS) Quality Improvement Scotland for permission to modify and use their Scottish Confidential Audit of Severe Maternal Morbidity notification and Major Obstetric Haemorrhage forms for a similar audit in Ireland.

Appendix C: Proforma for Management of a major obstetric haemorrhage

Mother's Name _____

Date of birth _____

Hospital Number _____

Obstetric Haemorrhage Documentation

Date … /… /…. Time ……..
Clinical Area……..
Person completing form ……..Staff Grade……
Signature ……..……
Primary Cause of Obstetric Haemorrhage……
Total Estimated Blood Loss ……
Local obstetric emergency team activated Yes/No If Yes, time activated…….

	Name	Time informed	Time arrived
Clinical Midwife Manager			
Porter			
Consultant Obstetrician			
Consultant Anaesthetist			
Haematologist (or when contacted blood bank)			**N/A**

Other Staff present	Status	Other Staff present	Status

Management	Time	Treatment		Dose	Time	Order
Assess CAB, position & observations (MEWS)		Syntocinon (IM or slow IV injection)				
Oxygen		IM Syntometrine				
Cannula 1: Colour……		Syntocinon infusion				
Cannula 2: Colour……		Misoprostol				
FBC		Haemabate (Carboprost)	1			
Clotting screen & Cross match			2			
Crystalloids			3			
Assess urgency for transfusion			4			
Catheter			Further doses			
Bimanual compression						
Repair perineal trauma						

Blood products	Amount	Time	Further management		Details
RBC			Theatre	EUA	
FFP				B-Lynch	
Platelets				Balloon	
Cell salvage				Hysterectomy	
Other information	Blood warmer used Yes No			I Radiology	
	Body warmer used Yes No		Arterial line		Yes No
Debrief	Staff Yes No Woman/partner Yes No		HDU care/ ICU transfer		Yes No

Appendix D: Characteristics of 159 women with a major obstetric haemorrhage

Maternal age ranged from 18 to 45, with an average age of 33 (SD 6). Only one case did not report on maternal age.

Table 22: Ethnicity among women with a major obstetric haemorrhage

Ethnicity	2011 MOH %	2011 Census %
White Irish	67.0	85.8
Irish Traveller	1.9	0.7
Other white background	12.3	9.3
Asian/Asian Irish	11.3	1.9
Black/Black Irish	6.6	1.4
Other/mixed	0.9	0.9

Note: MOH, major obstetric haemorrhage

Table 23: Weight distribution among women with a major obstetric haemorrhage.

BMI Category (kgm^{-2})	2011 MOH %	2007 SLÁN %
Underweight (<18.5)	2.1	2
Healthy (18.5 - 24.9)	36.2	44
Overweight (25.0 - 29.9)	33.0	31
Obese (>30.0)	28.7	23

Note: MOH, major obstetric haemorrhage; SLÁN, Survey of Lifestyle, Attitudes and Nutrition

Table 24: Substance use among women with a major obstetric haemorrhage

Substance use	%
Smoking at booking	13.5
Alcohol at booking	4.3

Table 25: Distribution of parity among women with a major obstetric haemorrhage

Parity	%
Nulliparous	42.1
Para 1	20.8
Para 2	18.2
Para 3+	18.9

Table 26: Number of previous caesarean sections among women with a major obstetric haemorrhage

Number	%
None	65.1
One	19.0
Two	8.7
Three	4.8
Four	2.4

Table 27: Gestational age at onset of morbidity among women with a major obstetric haemorrhage.

Gestational age in completed weeks	%
<20	3.9
20 to <24	1.3
24 to <28	2.6
28 to <35	11.6
35 to <37	12.3
37 to <42	66.5
42	1.9

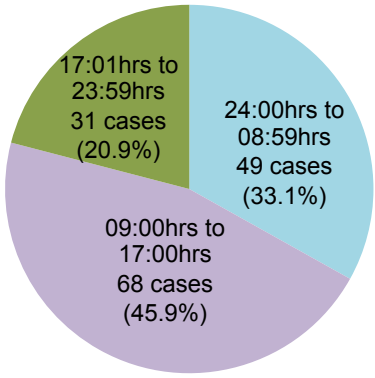


Figure 6: Time of major obstetric haemorrhage

Notes

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